# REB-3571LPX User Manual

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# 1 Introduction

RoyalTek REB-3571LPX low power and small form factor board is the newest generation of RoyalTek GPS module. The module is powered by latest SiRF Star III single chip and RoyalTek proprietary navigation technology that provides you with stable and accurate navigation data. The smallest form factor and miniature design is the best choice to be embedded in a device such as portable navigation device, personal locator, speed camera detector and vehicle locator.

**Product Features**

- ✧ 20 parallel channels
- ✧ SMT type with stamp holes
- ✧ TCXO design
- ✧ 0.1 second reacquisition time
- ✧ Small form factor with embedded SiRF Star III single chip technology.
- ✧ NMEA-0183 compliant protocol/customize protocol.
- ✧ Enhanced algorithm for navigation stability
- ✧ Excellent sensitive for urban canyon and foliage environments.
- ✧ DGPSBAS (WAAS, EGNOS and MSAS) support
- ✧ Auto recovery while RTC crashes
- ✧ Trickle power supported
- ✧ Build-in LNA and saw filter

## 1.1 Product applications

- ✧ Automotive navigation
- ✧ Personal positioning and navigation
- ✧ Marine navigation
- ✧ Timing application

## 1.2 Product Picture

**REB-3571LPX**




**Figure 1-1 REB-3571LPX Front View**

**REB-3571LPX Interface Board(Compatible with REB-3300 interface board)**

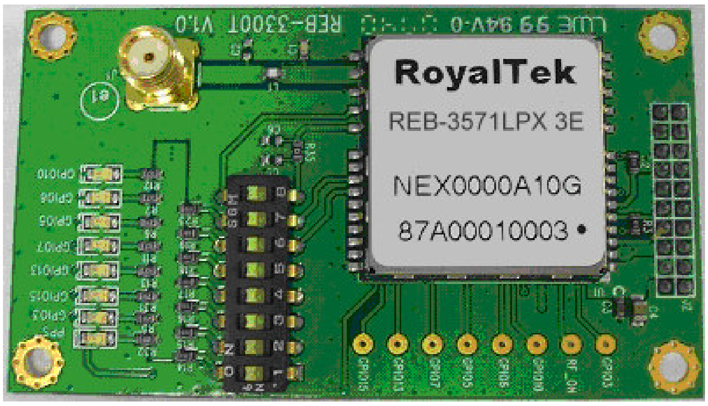



**Figure 1-2 REB-3571LPX Interface Board Front View**

**Table 1-1 The interface board pin definition**

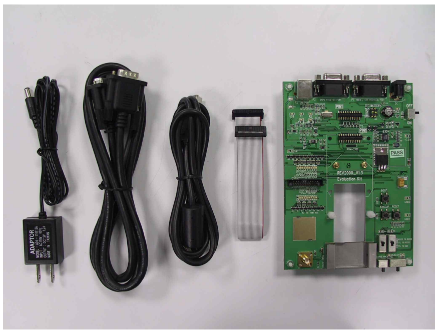
| PIN | REB-3310 | REB-3570LPX | REB-3571LPX |
|---|---|---|---|
| 1 | VCC | V_GPS_3V3 | VCC |
| 2 | GND | GND | GND |
| 3 | Bootselect | Bootselect | Bootselect |
| 4 | RXA | RXA | RXA |
| 5 | TXA | TXA | TXA |
| 6 | TXB | TXB | TXB |
| 7 | RXB | RXB | RXB |
| 8 | GPIO14 | N.C. | GPIO14 |
| 9 | RF-ON | RF-ON | RF-ON |

| | | | |
|---|---|---|---|
| 10 | GND | GND | GND |
| 11 | GND | N.C. | GND |
| 12 | GND | N.C. | GND |
| 13 | GND | GND | GND |
| 14 | GND | N.C. | GND |
| 15 | GND | GND | GND |
| 16 | GND | GND | GND |
| 17 | RF-IN | GPS_RF_IN | RF-IN |
| 18 | GND | GND | GND |
| 19 | V-ANT | V-ANT_IN | V-ANT |
| 20 | VCC-RF | VCC_RF_OUT | VCC-RF |
| 21 | V-BAT | V_RTC_3V3 | V-BAT |
| 22 | RESET-IN | RESET | RESET-IN |
| 23 | GPIO10 | N.C. | GPIO10 |
| 24 | GPIO1 | N.C. | GPIO1 |
| 25 | GPIO5 | GPIO4 | GPIO4 |
| 26 | GPIO0 | GPIO0 | GPIO0 |
| 27 | GPIO13 | N.C. | GPIO13 |
| 28 | GPIO15 | N.C. | GPIO15 |
| 29 | PPS | PPS | PPS |
| 30 | GND | GND | GND |
| 31 | NO PAD | N.C. | NO PAD |

**RoyalTek Evaluation Kit REV-2000 for REB-3571LPX(Compatible with REB-3300 evaluation kit)**

(Please refer to RoyalTek Evaluation Kit REV-2000 for REB-3310 Operational Manual for more information)

**Figure 1-3 Evaluation Kit Front View**



## 1.3 REB-3571LPX Series Block Diagram

REB-3571LPX engine board consists of SiRF star III single chipset technology; 4Mbits flash memory, and proprietary software. The system is described as follows.

a. External antenna.
b. 4 Mega bits flash memory
c. 30 pin I/O pin

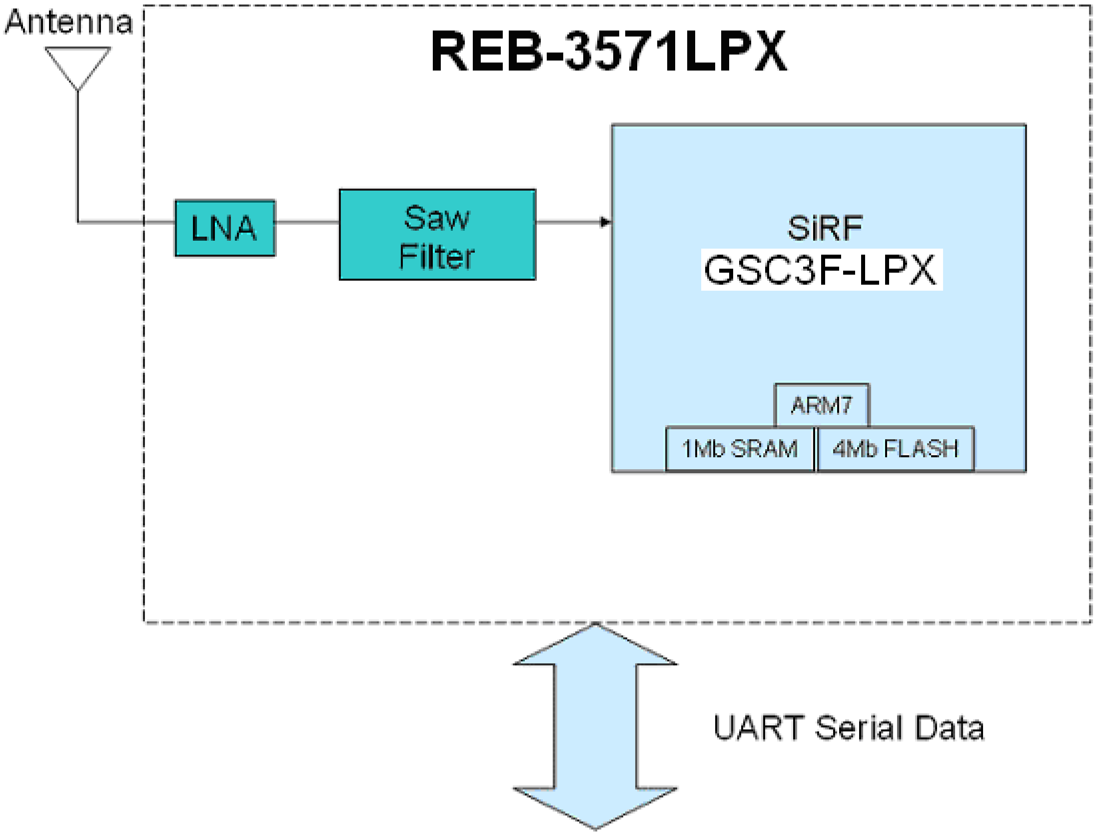



**Figure 1-5 System Block Diagram**

## 1.4 REB-3571LPX Technique Specification

**Impedance：50Ω**

**Table 1-2 Technical Specifications**

| No | Function | Specification |
|---|---|---|
| GPS receiver | | |
| 1 | Chipset | SiRF Star III, GSC3f/LPx<br>(Digital, RF in a single package) |
| 2 | Frequency | L1 1575.42MHz. |
| 3 | Code | C.A. Code. |
| 4 | Channels | 20 parallel |
| 5 | Chip Sensitivity | -159dBm |
| 6 | Chip set cold start | 35s @ open sky (Typical) |
| 7 | Chip set warm start | 35s @ open sky (Typical) |
| 8 | Chip set hot start | 1s @ open sky (Typical) |
| 9 | Reacquisition | less than 1s |
| 10 | Position accuracy | 10meters at 2D RMS. |
| 11 | Maximum altitude | 18000 m |
| 12 | Maximum velocity | 514 m/s |
| 13 | Trickle power mode | Duty cycle ≦ 34%. (Variable) |
| 14 | Update rate | Continuous operation: 1Hz |
| 15 | DGPS | WAAS, EGNOS |
| Interface | | |
| 16 | LNA | 15dB Gain. (Typical) |
| 17 | I/O Pin | 30pin |
| Power consumption | | |
| 18 | Vcc | DC 3.3 ±5% |
| 19 | Current | Avg. ≦ 48mA@3.3V(without ext. antenna) |
| Environment | | |
| 20 | Temperature | Operating : -40 ~ 85℃<br>Storage : -40 ~ 85℃ |
| 21 | Humidity | ≦95% |

## 1.5 Application Circuit

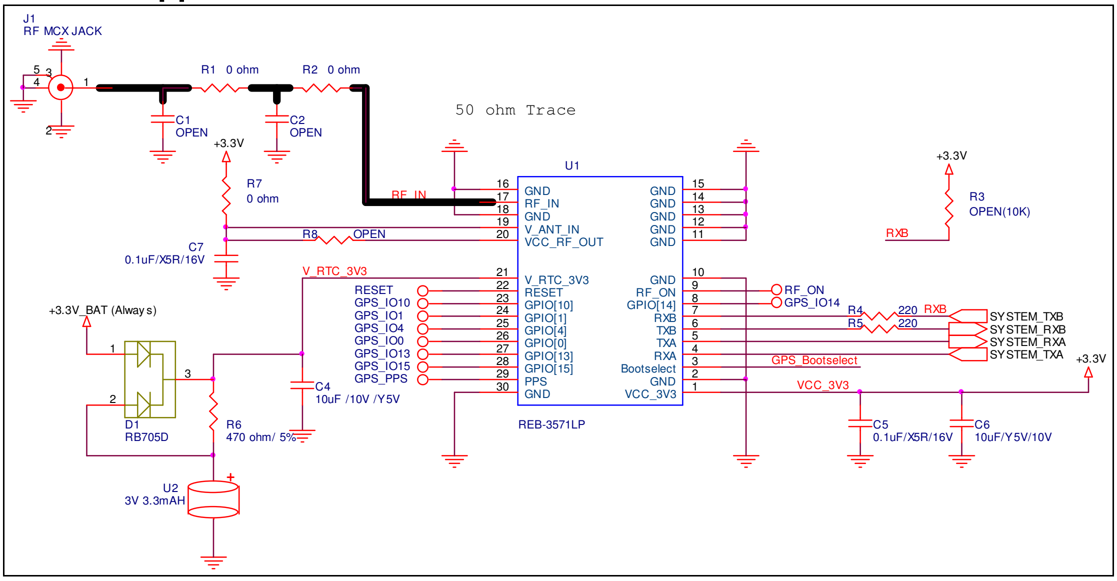



**Figure 1-6 Application Circuit Reference**

Note:

(1) Ground Planes:

These pin(2,10~16、18、30) should be connect to ground.

(2) Serial Interface:

( Ⅰ ) The TXA pin is the serial output data (Default NMEA) .

( Ⅱ ) The TXB pin is the serial output data (Default Null) .

( Ⅲ ) The RXA pin is the serial input data (Default NMEA) .

( Ⅳ ) The RXB pin is the serial input data (Default Null).

(3) Backup Battery:

When module is working, must to supply VCC_3V3(P1) and V_RTC_3V3 (P21) power at the same time.

It's recommended to connect a backup battery to V_RTC_3V3 pin.

In order to enable the warm start and hot start features of the GPS receiver.

If you use backup battery, should be add a bypassing capacitor (10uF) at V_RTC_3V3 pin. It can reduce noise and increase the stability.

(4) RF_IN:

Connecting to the antenna has to be routed on the PCB. The transmission line must to controlled impedance to connect RF_IN to the antenna or antenna connector of your choice. (Impedance 50Ω)

(5) Power:

Connect VCC_3V3 pin to DC +3.3V. The power supply must add bypassing capacitor (10uF and 0.1uF).It can reduce the Noise from power supply and

increase power stability.

(6) Active antenna bias voltage:

The VCC_RF_OUT pin (pin 20) is provide voltage 2.85V. If you use active antenna, you can connect this pin to V_ANT_IN pin (pin 19) to provide bias voltage of active antenna. The bias voltage will be through GPS_RF_IN pin to provide active antenna bias voltage from Vcc_RF_OUT pin.

If your bias voltage of active antenna isn't 2.85V, you can input bias voltage to V_ANT_IN pin (pin 19).And input bias voltage of you need. The input bias voltage will through GPS_RF_IN pin to provide active antenna bias voltage from V_ANT_IN pin.

PS:

(1) The maximum power consumption of active antenna is about 85mW.

(2) The input gain ranges are 19~ 22dB.

(7) GPIO:

The GPIO pin is recommended to connect to serial resistance(220Ω),if use the GPIO function.

If no use GPIO functions, it doesn't connect anything.

## 1.6 Recommended layout PAD

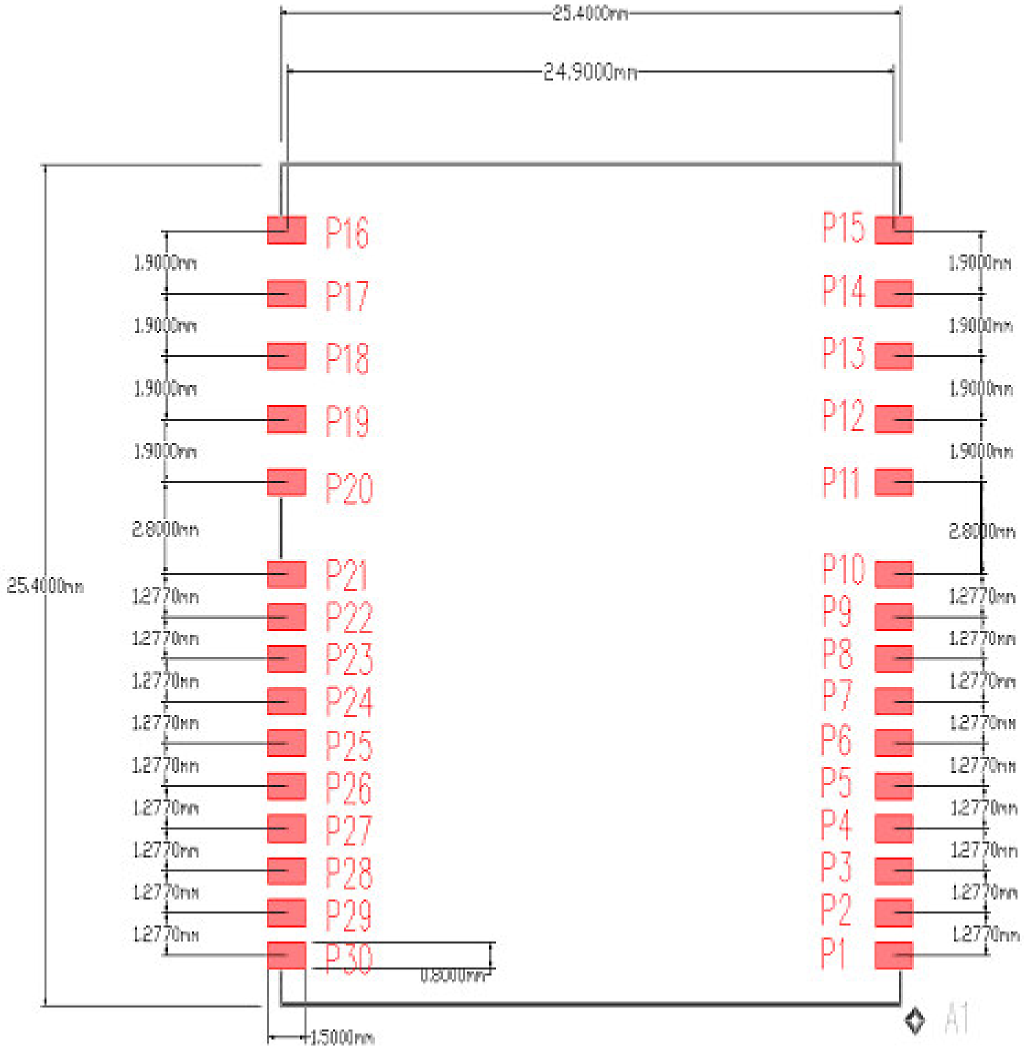



**Figure 1-7 Recommended Layout Pad**

### 1.7 Mechanical Layout

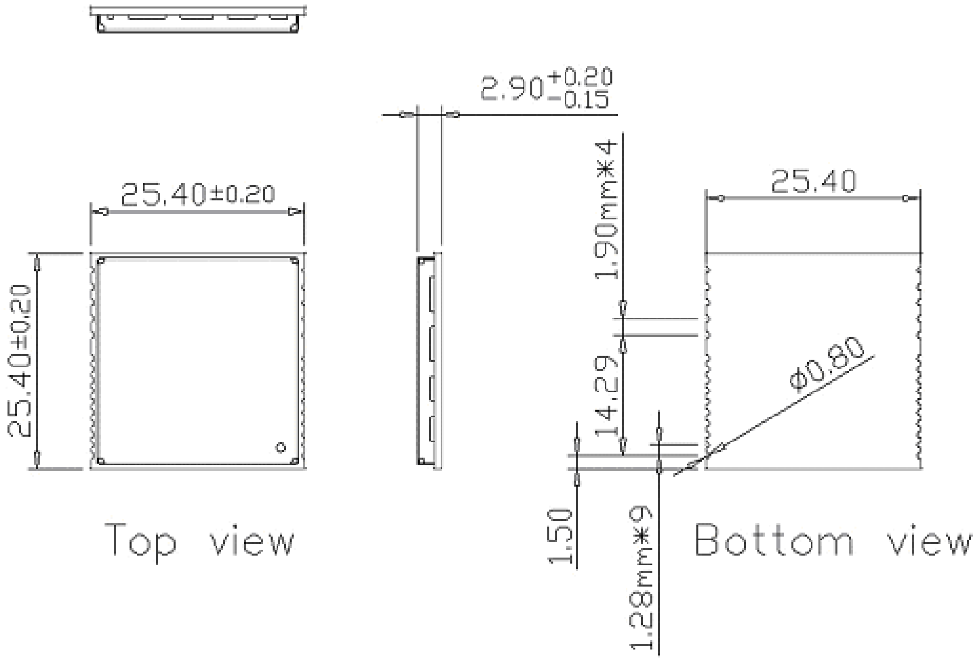



**Figure 1-8 Mechanical Layout**

### 1.8 REB-3571LPX-Test Software Specification

| No | Function | Specification |
|---|---|---|
| 1 | Clock offset | 88000Hz≦量測值≦104000Hz |
| 2 | Clock Drift | 量測值≦200Hz |
| 3 | C/No Hi Power Mean | 量測值≧39dB |
| 4 | C/No Hi Power Sigma | 量測值≦2dB |
| 5 | Bit Sync | 量測值≦5 Sec |
| 6 | Frame Sync | 量測值≦28 Sec |
| 7 | Phase Error | 量測值≦0.22 |
| 8 | RTC 測試 | |
| | RTC Frequency 測試 | 31000≦量測值≦33500 |

可靠性及品質目標

MTBF > 10000 hours.

### 1.9 Hardware interface

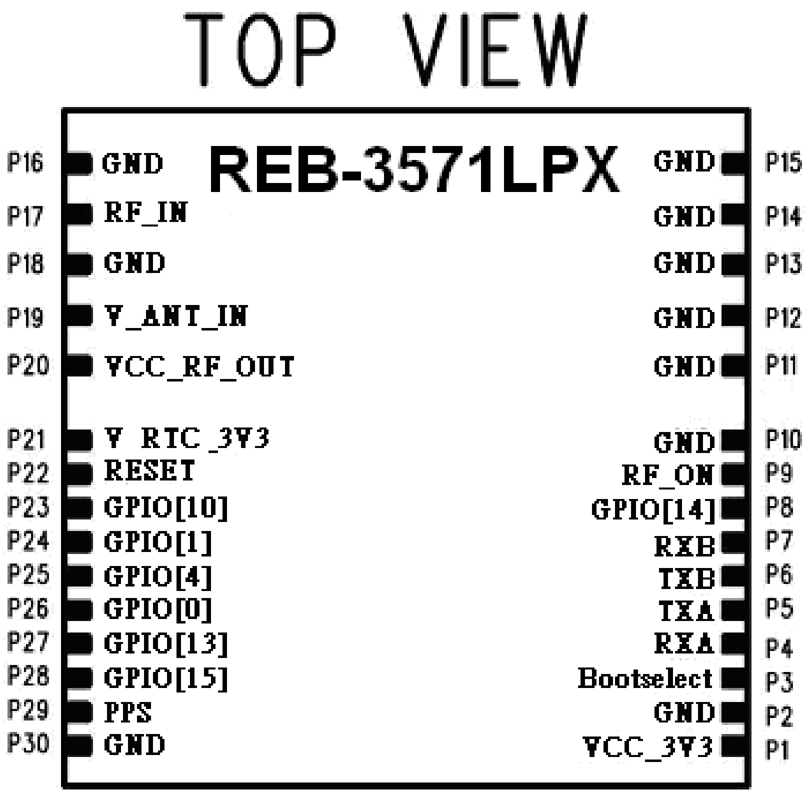



**Figure 1-9 Hardware Interface**

**Table 1-3 Definition of Pin assignment**

| Pin # | Signal Name | I/O | Description | Characteristics |
|---|---|---|---|---|
| 1 | VCC_3V3 | I | DC Supply Voltage input | DC +3.3V±5% |
| 2 | GND | G | Ground | Reference Ground |
| 3 | Bootselect | I | Boot mode | $3.15V \ge V_{IH} \ge 2.0V$ $-0.3V \le V_{IL} \le 0.86V$ |
| 4 | RXA | I | Serial port A | $3.15V \ge V_{IH} \ge 2.0V$ $-0.3V \le V_{IL} \le 0.86V$ |
| 5 | TXA | O | Serial port A | $2.85V \ge V_{OH} \ge 2.14V$ $V_{OL} \le 0.71V$ |
| 6 | TXB | O | Serial port B | $2.85V \ge V_{OH} \ge 2.14V$ $V_{OL} \le 0.71V$ |
| 7 | RXB | I | Serial port B | $3.15V \ge V_{IH} \ge 2.0V$ $-0.3V \le V_{IL} \le 0.86V$ |
| 8 | GPIO[14] | I/O | General purpose I/O | $3.15V \ge V_{IH} \ge 2.0V$ $-0.3V \le V_{IL} \le 0.86V$<br>$2.85V \ge V_{OH} \ge 2.14V$ $V_{OL} \le 0.71V$ |
| 9 | RF_ON | O | Indicates power state | $V_{OH} = 2.85V$ $V_{OL} = 0V$ |

| | | | | |
|---|---|---|---|---|
| | | | of RF part | |
| 10 | GND | G | Ground | Reference Ground |
| 11 | GND | G | Ground | Reference Ground |
| 12 | GND | G | Ground | Reference Ground |
| 13 | GND | G | Ground | Reference Ground |
| 14 | GND | G | Ground | Reference Ground |
| 15 | GND | G | Ground | Reference Ground |
| 16 | GND | G | Ground | Reference Ground |
| 17 | RF_IN | I | GPS Signal input | 50 Ω @1.57542GHz |
| 18 | GND | G | Ground | Reference Ground |
| 19 | V_ANT_IN | I | Active Antenna Bias voltage | Receiving DC power supply for active antenna bias. |
| 20 | VCC_RF_OUT | O | Supply Antenna Bias voltage | DC +2.85V ±2%<br>Current<30mA |
| 21 | V_RTC_3V3 | I | Backup voltage supply | DC + 2.5 ~ +3.6V<br>Current $\leq$ 10uA |
| 22 | Reset | I | Reset (Active low) | $V_{IH} > 2.3V$ $V_{IL} < 0.8V$ |
| 23 | GPIO[10] | I/O | General purpose I/O | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$<br>$2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 24 | GPIO[1] | I/O | General purpose I/O | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$<br>$2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 25 | GPIO4 | I/O | General purpose I/O | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$<br>$2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 26 | GPIO0 | I/O | General purpose I/O | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$<br>$2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 27 | GPIO[13] | I/O | General purpose I/O | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$<br>$2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 28 | GPIO[15] | I/O | General | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$ |

| | | | | |
|---|---|---|---|---|
| | | | purpose I/O | $2.85V \geq V_{OH} \geq 2.14V$ $V_{OL} \leq 0.71V$ |
| 29 | PPS | O | One pulse per second | $3.15V \geq V_{IH} \geq 2.0V$ $-0.3V \leq V_{IL} \leq 0.86V$ |
| 30 | GND | G | Ground | Reference Ground |

**Definition of Pin assignment**

**VCC_3V3 (+3.3V DC power Input)**

This is the DC power supply input pin for GPS system. It provides voltage to module.

**GND**

GND provides the ground .

**Boot**

Set this pin to high for programming flash.

**RXA**

This is the main receiver channel and is used to receive software commands to the board from SIRFdemo software or from user written software.

**RXB**

This is the auxiliary receiving channel and is used to input differential corrections to the board to enable DGPS navigation.

**TXA**

This is the main transmitting channel and is used to output navigation and measurement data to SiRFdemo or user written software.

**TXB**

For user's application (not currently used).

**RF_ON**

This pin indicates state of RF voltage.

**GPS_RF_IN**

This pin receives GPS analog signal. The line on the PCB between the antenna(or antenna connector) has to be a controlled impedance line (Microstrip at 50Ω).

**V_ANT_IN**

This pin is reserved as external DC power supply input for active antenna.
If using 2.85V active antenna, pin 20 has to be connected to pin 19.
If using 3.3V or 5V active antenna ,this pin has to be connected to 3.3V or 5V power supply.
PS: The current must be ≦100mA and voltage ≦12V,if using external power

supply.

**VCC_RF_OUT**

This pin can provide power 30mA@2.85V for active antenna.

**Reset**

This pin provides an active-low reset input to the board. It causes the board to reset and start searching for satellites. If not utilized, it may be left open.

**PPS**

This pin provides one pulse-per-second output from the board, which is synchronized to GPS time. This is not available in Trickle Power mode.

**V_RTC_3V3 (Backup battery)**

This is the battery backup input that powers the SRAM and RTC when main power is removed. Typical current draw is 10uA.

The supply voltage should be between 2.5V and 3.6V.

**GPIO Functions**

Several I/Os are connected to the digital interface connector for custom applications.

# 2 Software Interface

## 2.1 NMEA V3.0 Protocol

**NMEA Protocol**

NMEA Output Messages: the Engine board outputs the following messages as shown in Table 2-1:

**Table 2-1 NMEA-0183 Output Messages**

| NMEA Record | Description |
|---|---|
| GGA | Global positioning system fixed data |
| GSA | GNSS DOP and active satellites |
| GSV | GNSS satellites in view |
| RMC | Recommended minimum specific GNSS data |
| GLL | Geographic position – latitude/longitude |
| VTG | Course over ground and ground speed |

**GGA-Global Positioning System Fixed Data**

Table 2-2 contains the values of the following example:

$GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,0000*18

**Table 2-2 GGA Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGGA | | GGA protocol header |
| UTC Position | 161229.487 | | hhmmss.sss |
| Latitude | 3723.2475 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12158.3416 | | Dddmm.mmmm |
| E/W Indicator | W | | E=east or W=west |
| Position Fix Indicator | 1 | | See Table 2-1 |
| Satellites Used | 07 | | Range 0 to 12 |
| HDOP | 1.0 | | Horizontal Dilution of Precision |
| MSL Altitude | 9.0 | meters | |
| Units | M | meters | |
| Geoid Separation | | meters | |
| Units | M | meters | |
| Age of Diff. Corr. | | second | Null fields when DGPS is not used |
| Diff. Ref. Station ID | 0000 | | |
| Checksum | *18 | | |

| | | | |
|---|---|---|---|
| ＜CR＞＜LF＞ | | | End of message termination |

**Table 2-3 Position Fix Indicators**

| Value | Description |
|---|---|
| 0 | Fix not available or invalid |
| 1 | GPS SPS Mode, fix valid |
| 2 | Differential GPS, SPS Mode, fix valid |
| 3-5 | Not Supported |
| 6 | Dead Reckoning Mode, fix valid |

**GSA-GNSS DOP and Active Satellites**

Table 2-4 contains the values of the following example:

$GPGSA, A, 3, 07, 02, 26, 27, 09, 04, 15, , , , , , 1.8,1.0,1.5*33

**Table 2-4 GSA Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSA | | GSA protocol header |
| Mode 1 | A | | See Table 5 |
| Mode 2 | 3 | | See Table 6 |
| ID of Satellite Used | 07 | | Sv on Channel 1 |
| ID of Satellite Used | 02 | | Sv on Channel 2 |
| …. | | | …. |
| ID of Satellite Used | | | Sv on Channel 12 |
| PDOP | 1.8 | | Position Dilution of Precision |
| HDOP | 1.0 | | Horizontal Dilution of Precision |
| VDOP | 1.5 | | Vertical Dilution of Precision |
| Checksum | *33 | | |
| ＜CR＞＜LF＞ | | | End of message termination |

**Table 2-5 Mode 1**

| Value | Description |
|---|---|
| M | Manual-forced to operate in 2D or 3D mode |
| A | Automatic-allowed to automatically switch 2D/3D |

**Table 2-6 Mode 2**

| Value | Description |
|---|---|
| 1 | Fix not available |
| 2 | 2D |
| 3 | 3D |

**GSV-GNSS Satellites in View**

Table 2-7 contains the values of the following example:

$GPGSV, 2, 1, 07, 07, 79, 048, 42, 02, 51, 062, 43, 26, 36, 256, 42, 27, 27, 138, 42*71

$GPGSV, 2, 2, 07, 09, 23, 313, 42, 04, 19, 159, 41, 15, 12, 041, 42*41

**Table 2-7 GSV Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSV | | GSV protocol header |
| Total Number of Messages[1] | 2 | | Range 1 to 3 |
| Messages Number[1] | 1 | | Range 1 to 3 |
| Satellites in View | 07 | | |
| Satellite ID | 07 | | Channel 1(Range 1 to 32) |
| Elevation | 79 | degrees | Channel 1(Range 00 to 90) |
| Azimuth | 048 | degrees | Channel 1(True, Range 000 to 359) |
| SNR (C/No) | 42 | dBHz | Channel 1(Range 0 to 99, null when not tracking) |
| Satellite ID | 27 | | Channel 4(Range 01 to 32) |
| Elevation | 27 | degrees | Channel 4(Range 00 to 90) |
| Azimuth | 138 | degrees | Channel 4(True, Range 000 to 359) |
| SNR (C/No) | 42 | dB-Hz | Channel 4(Range 00 to 99, null when not tracking) |
| Checksum | *71 | | |
| ＜CR＞＜LF＞ | | | End of message termination |

[1]Depending on the number of satellites tracked multiple messages of GSV data may be required.

**RMC-Recommended Minimum Specific GNSS Data**

Table 2-8 contains the values of the following example:

$GPRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13, 309.62, 120598, ,*10

**Table 2-8 RMC Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPRMC | | RMC protocol header |
| UTC Time | 161229.487 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Latitude | 3723.2475 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12158.3416 | | dddmm.mmmm |
| E/W Indicator | W | | E=east or W=west |
| Speed Over Ground | 0.13 | knots | True |
| Course Over Ground | 309.62 | degrees | |
| Date | 120598 | | ddmmyy |
| Magnetic Variation | | degrees | |
| Variation sense | | | E=east or W=west (Not shown) |
| Mode | A | | A=Autonomous, D=DGPS, E=DR |
| Checksum | *10 | | |
| <CR><LF> | | | End of message termination |

**VTG-Course Over Ground and Ground Speed**

Table 2-9 contains the values of the following example:

$GPVTG,79.65,T,,M,2.69,N,5.0,K,A*38

**Table 2-9 VTG Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPVTG | | VTG protocol header |
| Course over rgound | 79.65 | degrees | Measured heading |
| Reference | T | | True |
| Course over ground | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed over ground | 2.69 | Knots | Measured speed |
| Units | N | | Knots |
| Speed over ground | 5.0 | Km/hr | Measured speed |
| Units | K | | Kilometer per hour |
| Mode | A | | A-autonomous, D=DGPS, E=DR |
| Checksum | *38 | | |
| <CR><LF> | | | End of message termination |

**GLL-Geographic Position – Latitude/Longitude**

Table 2-10 contains the values of the following example:

$GPGLL,2503.6319,N,12136.0099,E,053740.000,A,A*52

**Table 2-10 GLL Data Format**

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGLL | | GLL protocol header |
| Latitude | 2503.6319 | | ddmm.mmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12136.0099 | | Dddmm.mmmm |
| E/W indicator | E | | E=east or W=west |
| UTC Time | 053740.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Mode | A | | A=autonomous, D=DGPS, E=DR |
| Checksum | *52 | | |
| <CR><LF> | | | End of message termination |

# 3 GPS Receiver User's Tip

A. GPS signal will be affected by weather and environment conditions, thus suggest to use the GPS receiver under less shielding environments to ensure GPS receiver has better receiving performance.

B. When GPS receiver is moving, it will prolong the time to fix the position, so suggest to wait for the satellite signals to be locked at a fixed point when first power-on the GPS receiver to ensure to lock the GPS signal at the shortest time.

C. The following situation will affect the GPS receiving performance:

   i. Solar control filmed windows.
   ii. Metal shielded, such as umbrella, or in vehicle.
   iii. Among high buildings.
   iv. Under bridges or tunnels.
   v. Under high voltage cables or near by radio wave sources, such as mobile phone base stations.
   vi. Bad or heavy cloudy weather.

D. If the satellite signals can not be locked or encounter receiving problem (while in the urban area), the following steps are suggested:

   i. Please plug the external active antenna into GPS receiver and put the antenna on outdoor or the roof of the vehicle for better receiving performance.
   ii. Move to another open space or reposition GPS receiver toward the direction with less blockage.
   iii. Move the GPS receiver away from the interferences resources.
   iv. Wait until the weather condition is improved.

E. While a GPS with a backup battery, the GPS receiver can fix a position immediately at next power-on if the build-in backup battery is full-recharged.

### 3.1 Package Specification and Order Information

Shipment Method: Tape and reel

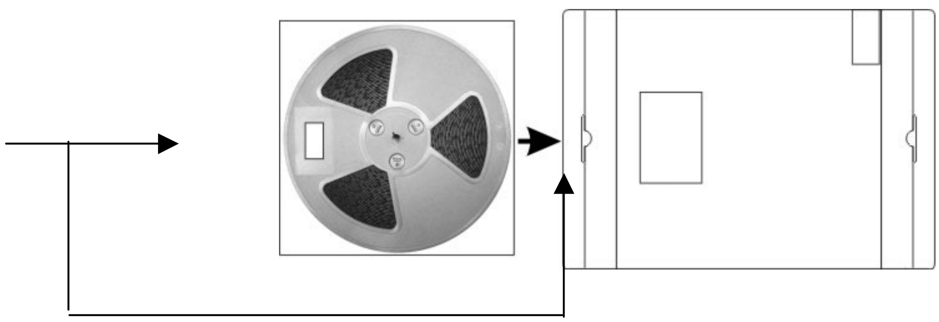
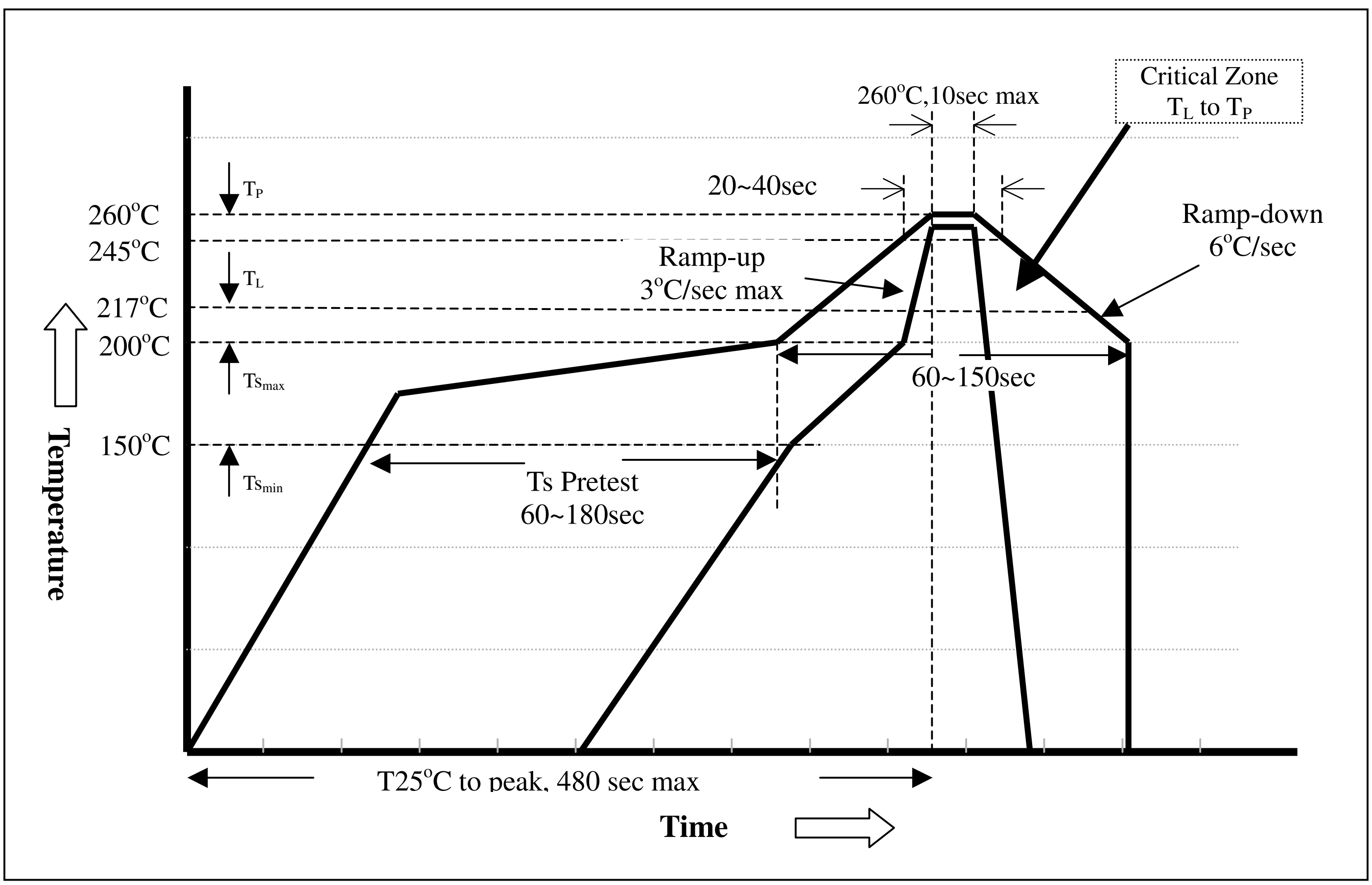


**Figure 3-1 Package Specifications**

### 3.2 Lead-Free Standard Reflow Profile




REB-3571LPX Lead-Free Standard Reflow Profile

# 4 Contact Information Section

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# 5 Revision History

| Title | REB-3571LPX GPS Module | | |
|---|---|---|---|
| Doc Type | User Manual | | |
| Revision Number | Date | Author | Change notice |
| 1.0 | 2007/09/29 | Amy Liu | Initial Release |